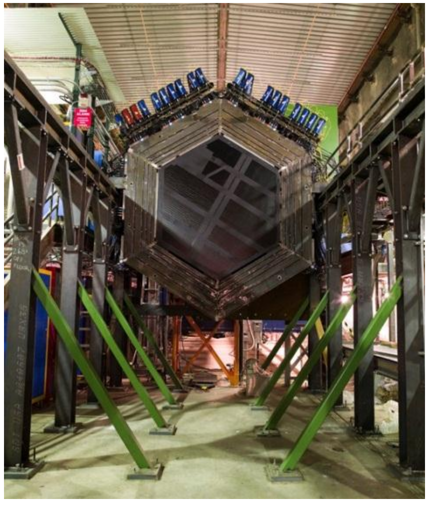
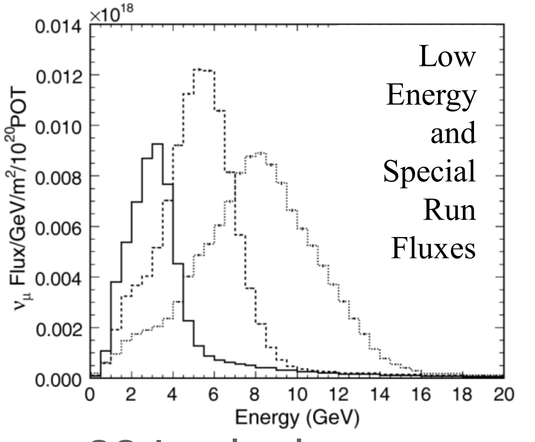
MINERvA Overview

- MINERvA is studying neutrino interactions in unprecedented detail
- Low Energy (LE) Beam Goals:
  - Study both signal and background reactions relevant to oscillation experiments (current and future)
  - Nuclear effects on exclusive final states
    - as function of a measured neutrino energy
    - may be different for neutrino and anti-neutrino
  - Precise understanding important for oscillation expt's
- Medium Energy (ME) Beam (NOvA) Goals:
  - Structure Functions on various nuclei
- NuMI Beamline Provides
  - High intensity, Wide range of available energies
- MINERvA detector Provides
  - Reconstruction in different nuclei, broad range of final states



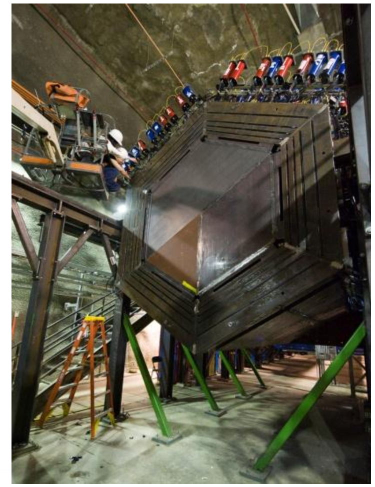


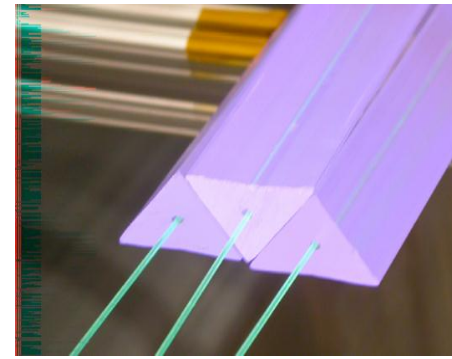
~100 Particle, Nuclear, and Theoretical physicists from 22 Institutions

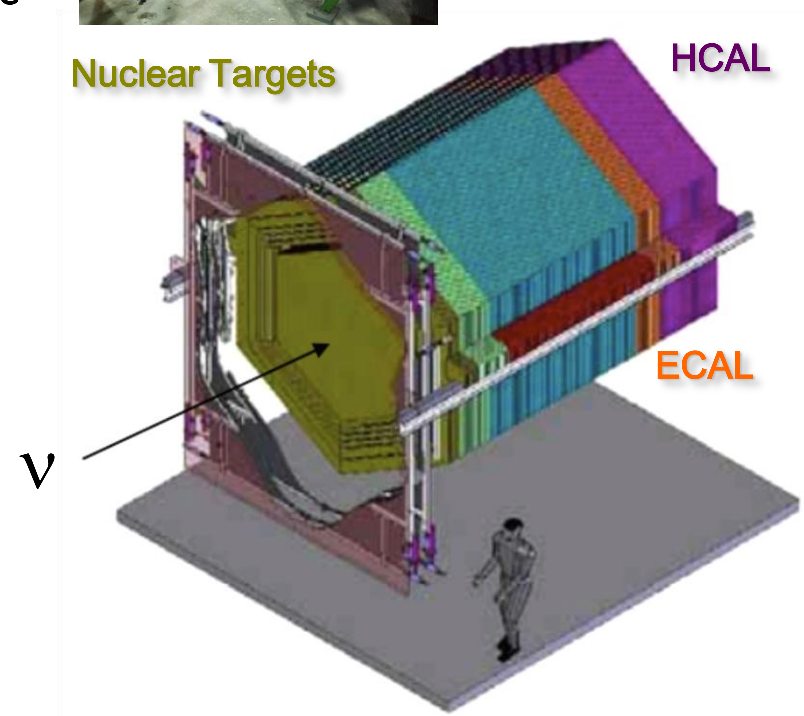
      

MINERvA Detector Basics

- Nuclear Targets
  - Allows side by side comparisons between different nuclei
  - Solid C, Fe, Pb, He and water coming soon
- Solid scintillator tracker
  - Tracking, particle ID, calorimetric energy measurements
  - Low visible energy thresholds
- Side and downstream Electromagnetic and Hadronic Calorimetry
  - Allow for event energy containment
- MINOS Near Detector
  - Provides muon charge and momentum



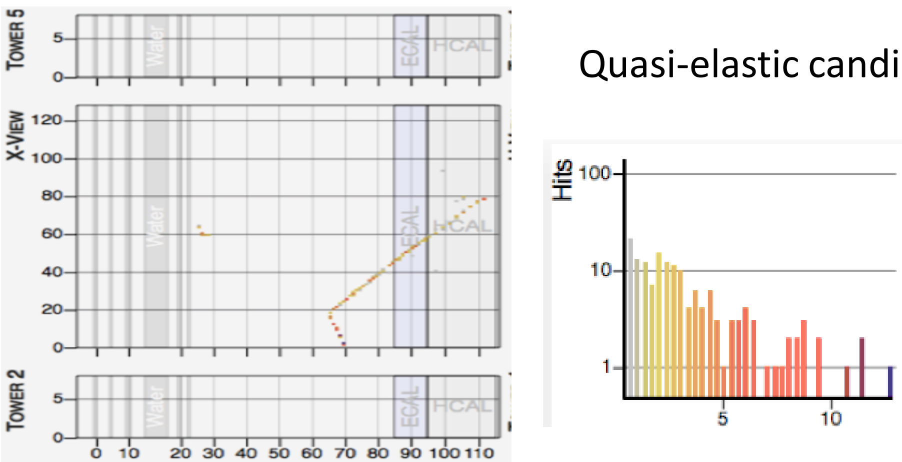




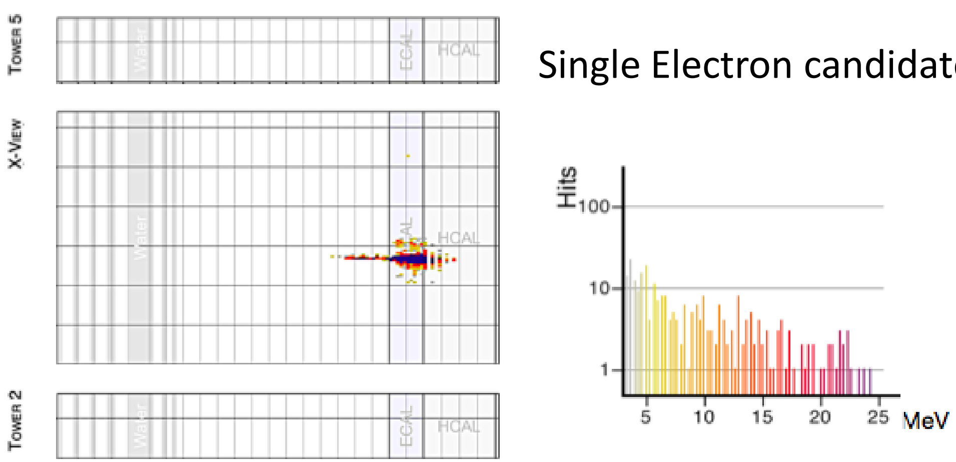
MINERvA Data

- One out of three views shown, color=energy

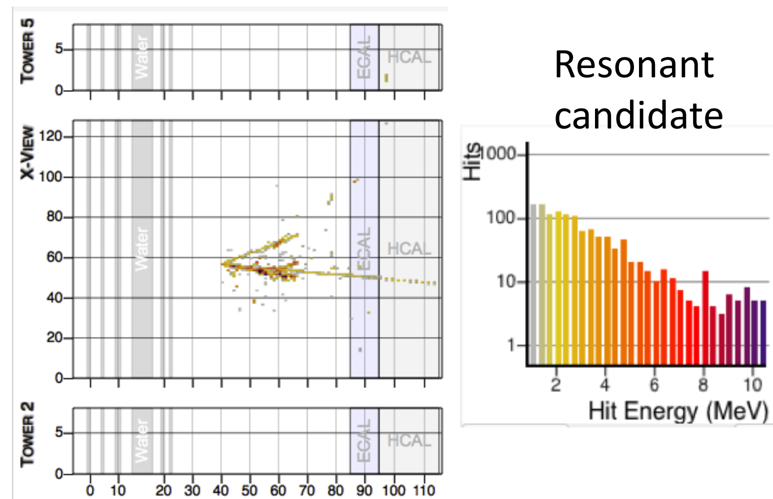
Quasi-elastic candidate



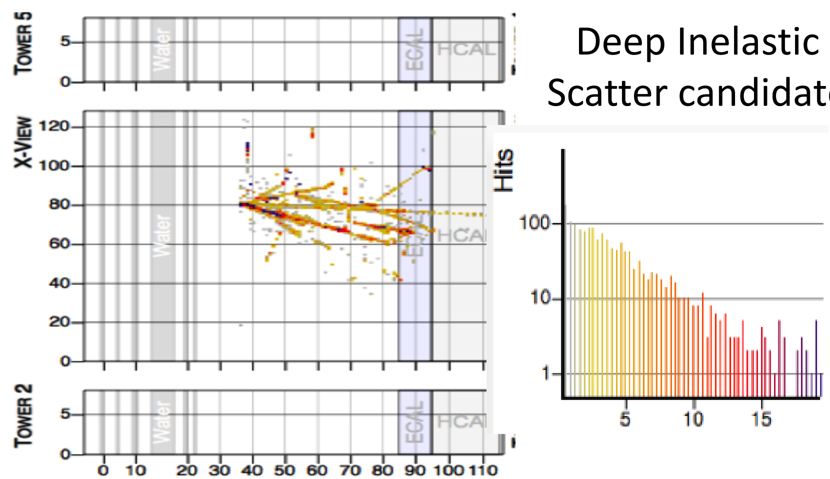
Single Electron candidate



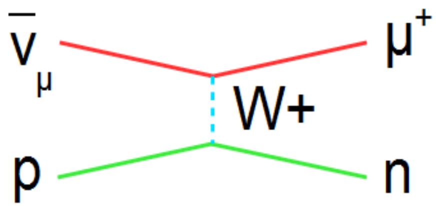
Resonant candidate



Deep Inelastic Scatter candidate

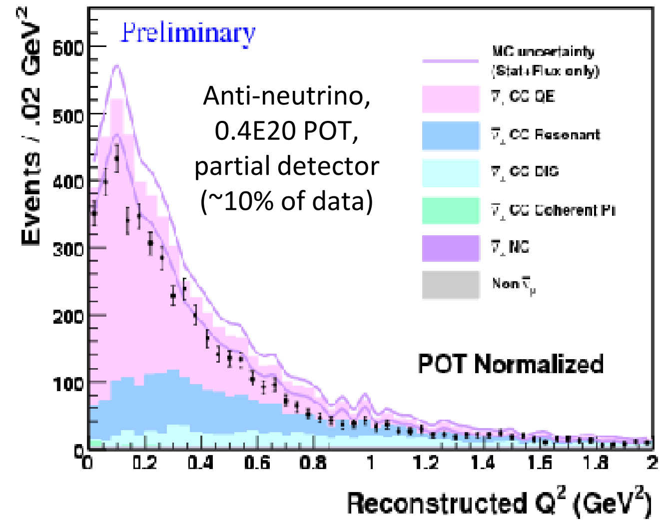


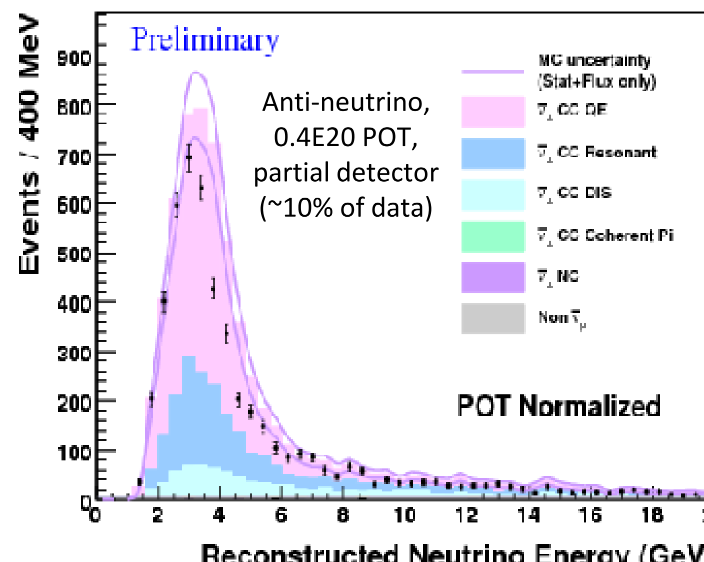
MINERνA: Quasi-Elastic Analysis



- Relatively Simple Final state
  - Require Muon, plus little or no extra energy
- Primary interaction type for neutrino oscillation experiments
- Measuring muon energy and angle (with rexpect to beam) completely reconstructs a quasi-elastic interaction:
  - neutrino energy
  - momentum transfer to nucleon (Q^2)
- Preliminary analysis of first half of anti-neutrino data taken during final detector construction period, represents about 1/10 of current data set.
  - Band on plots shows current flux uncertainty

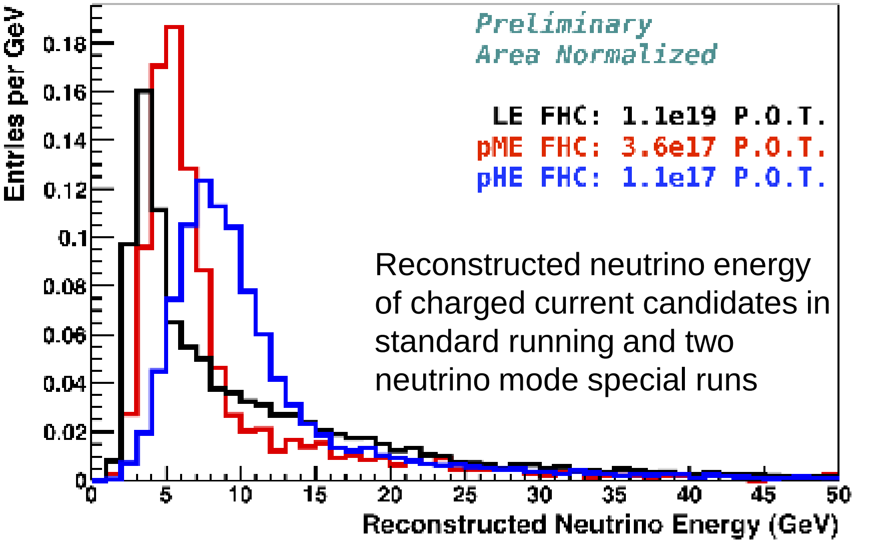
$$Q^2 = 2E^{QE}_{\bar{\nu}_\mu}\left(E_\mu - p_\mu \cos(\theta_\mu)\right) - m_\mu^2$$



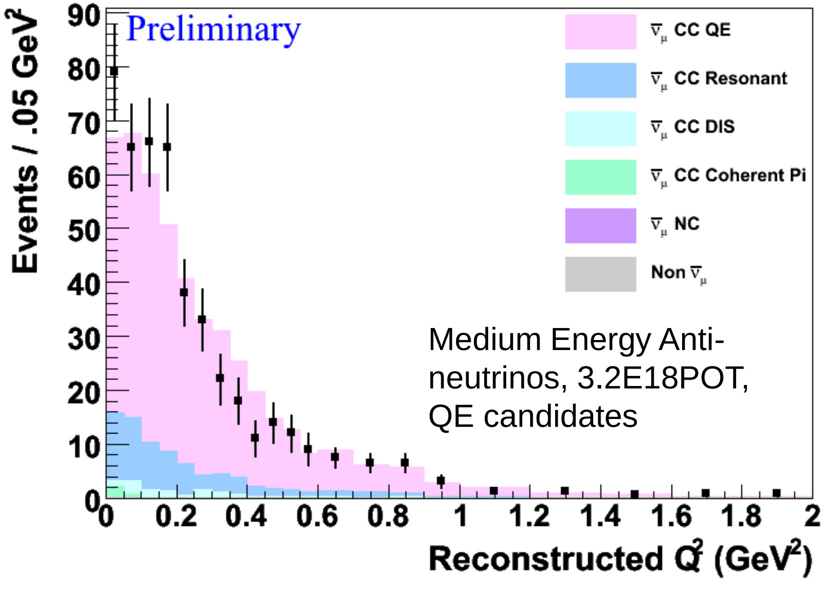


MINERνA: Special Runs to understand Neutrino Flux

- Goal: to test flux model by taking neutrino data in several different configurations
  - Map through pion production spectrum
  - Change transverse and longitudinal focusing
  - Standard candle cross sections should be independent of incident neutrino flux
- Capability unique to NuMI beamline
- Standard candles available:
  - Inclusive Charged Current events
  - Quasi-Elastic Events
- Have taken 3 out of 6 run configurations, half statistics per run
  - Medium, High energy target positions
  - Horn off data (no focusing)
- Developing Data Reconstruction and Flux Tuning Infrastructure in parallel



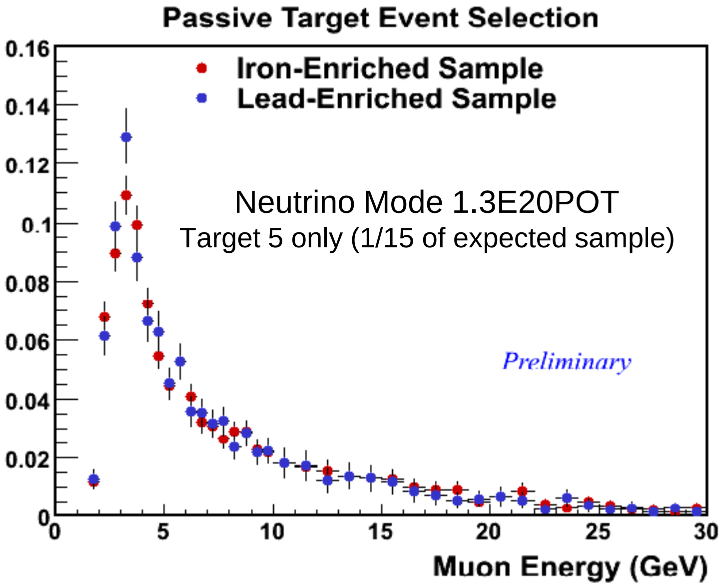
Reconstructed neutrino energy of charged current candidates in standard running and two neutrino mode special runs



Medium Energy Anti-neutrinos, 3.2E18POT, QE candidates

MINERνA: Nuclear Target Analysis

- MINERvA has 5 solid nuclear targets
  - Different thicknesses good for different analyses: most downstream target best for exclusive final state analyses
- First look at inclusive Charged Current (CC) events from Fe and Pb



First muon energy spectra in targets; ratios coming soon!

Target	Fiducial Mass	ν_μ CC Events in 4E20 POT
Plastic	6.43 tons	1363k
Helium	0.25 tons	56k
Carbon	0.17 tons	36k
Water	0.39 tons	81k
Iron	0.97 tons	215k
Lead	0.98 tons	228k